whether such is always the law of evolution, and taking place in every plant, is, I think, not sufficiently proved. In *Tilia* especially this law, however, can be seen operating, in the formation of the spiral fibres on the wall of the cells of the pleurenchyma. That the *continuous* spiral development is the base of all forms of annular reticulated and dotted vessels I think certain, and the various metamorphoses which arise from such base are to be sought for in the peculiar after-growth of the primary structureless membrane upon which the secondary fibrous layers were originally deposited. Very often, as may be seen in *Tilia*, this membrane becomes entirely absorbed, the coils of the secondary spire brought close together; and this happening during the development of the fibres, the spiral continuity ceases to exist; the molecules from which the fibres are formed hence pass into a series of more or less broad, flat, and continuous bands; and vessels formed of such fibres, totally destitute of primary membrane, are to be found in the plant just referred to. In fact, much of the tissue of *Tilia* represents many stages and states of evolution of the secondary fibrous layers in connexion with peculiar after-growth of the primary structure upon which they have been deposited. I have observed *compound* spiral vessels in the petiole of *Tilia pubescens*.

4.—On the under surface of the leaf of *Adelia nereifolia* may be found a very beautiful and peculiar form of scale; it consists of two circular layers of cellular membrane, the one layer of much smaller diameter than the other, puckered and plaited, and of a saucer-shaped form; it is fixed by its centre, which apparently is connected with a *gland* having coloured contents. From this form of scale, through that met with on *Eleagnus conferta*, I think transitional states may be seen, to the stellate hairs of many of the *Euphorbiaceæ* and *Malvaceæ*; in fact, upon the peculiar adhesions taking place between the cells depends the appearance of the stellate hair or the scale of *Adelia* and *Eleagnus*. The occurrence both of stellate hairs and this form of scale in *Euphorbiaceæ*, shows the structural differences between the two not to be great in their origin.

[To be continued.]

X.—*On the Separation of the Pomegranate as a distinct Natural Order from* Myrtaceæ. By Robert Wight, M.D., F.L.S., &c.*

The most eminent botanists of the present day being divided in opinion as to the propriety or otherwise of separating the

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Pomegranate as a distinct natural order from *Myrtaceæ*, I have recently been induced to examine this question, bringing to my aid the lights thrown on carpellary arrangement by my recent investigations of *Cucurbitaceæ*. (Annals, viii. 260.)

The result of this examination has led me to the conviction, not only that *Granateæ* is a distinct order, but that the pomegranate, if my views are correct, is, so far as our information yet extends, the most remarkable fruit in the system of plants. But, without further preface, I shall at once proceed with the subject, introducing it by presenting a series of extracts from the leading disputants on either side. The whole controversy turns on a simple question of fact, namely, What is the structure of the ovary and fruit of *Punica*? To these points therefore I shall, to save room, limit my extracts. The first of these, taking them in chronological order, is from Mr. D. Don's paper, 'Edin. New Philosoph. Journal' for July 1826. The second is from DeCandolle's 'Prod.,' iii. p. 3. The third is from Dr. Lindley's 'Natural System of Botany,' ed. 1st, p. 64, and repeated in the second edition, p. 43. The last is from Mr. Arnott's article Botany, 'Encycl. Brit.,' ed. 7, p. 110, under *Myrtaceæ*. These extracts, by placing the question before the reader in all its bearings, will enable him at once to judge how far I have succeeded in setting the question at rest.

"*Bacca* pomiformis, limbo tubulosa dentato calycino, nunc contracto, coronata: *cortex* crassissimus, extùs cuticulâ lævi rubicundâ punctatâ lucidâ vestitus, intus spongioso-carnosus, albus, dein, maturâ baccâ, fissurâ irregulariter rumpens. *Placenta* cortici baccæ substantiâ simillima, at magis carnosa et succulenta baccam omnino replens, in loculis numerosis polyspermis inæqualibus reticulatim atque interruptè excavata. *Dissepimenta vera* nulla: *spuria* tamen adsunt, quæ e substantiâ placentæ orta, valdè sunt fragilia, et crassitie variâ."—*Don* (*l. c.*).

"The real structure of the fruit of the pomegranate appears to have been overlooked by all authors I have consulted on the subject, and even the distinguished Gærtner has fallen into error both in his description and figure. It is in reality a fleshy receptacle, formed by the tube of the calyx into a unilocular berry, filled with a spongy placenta, which is hollowed out into a number of irregular cells in which the seeds are placed; the dissepiments being nothing more than thin portions of the placenta. If we could conceive the fruit of *Rosa* to be filled up with an interrupted pulpy matter, it would be exactly of the same structure as the pomegranate."—*Don* (*l. c.*).

"Fructus magnus, sphæricus, calycis limbo subtubuloso coronatus, ejusdem tubo corticatus, indehiscens, diaphragmate horizontali inæqualiter bicameratus; camerâ superiore 5—9-loculari, camerâ inferiore minore 3-loculari, septis utriusque membranaceis loculos separantibus; placentæ cameræ superioris carnosæ a parietibus ad centrum tendentes, in inferiore processus irregulares ab ipso fundo."—*DeC.* (*l. c.*).

"The fruit of the pomegranate is described by Gærtner and De Candolle as being divided into two unequal divisions by a horizontal diaphragm, the upper half of which consists of from five to nine cells, and the lower of three; the cells of both being separated by membranous dissepiments; the placenta of the upper half proceeding from the back to the centre, and of the lower irregularly from their bottom: and by Mr. Don as a fleshy receptacle formed by the tube of the calyx into a unilocular berry, filled with a spongy placenta, which is hollowed out into a number of irregular cells. In fact, if a pomegranate is examined, it will be found to agree more or less perfectly with both these descriptions. But it is clear that a fruit as thus described is at variance with all the known laws upon which compound fruits are formed. Nothing, however, is more common than that the primitive construction of fruits is obscured by the additions, or suppressions, or alterations, which its parts undergo during their progress to maturity. Hence it is always desirable to obtain a clear idea of the structure of the ovarium of all fruits which do not obviously agree with the ordinary laws of carpological composition. Now a section of the ovarium of the pomegranate in various directions, if made about the time of the expansion of the flowers before impregnation takes place, shows that it is in fact composed of two rows of carpella, of which three or four surround the axis, and are placed in the bottom of the tube of the calyx, and a number, varying from five to ten, surround these, and adhere to the upper part of the tube of the calyx. The placentæ of these carpella contract an irregular kind of adhesion with the back and front of their cells, and thus give the position ultimately acquired by the seeds that anomalous appearance which it assumes in the ripe fruit. If this view of the structure of the pomegranate be correct, its peculiarity consists in this, that, in an order the carpella of which occupy but a single row around the axis, it possesses carpella in two rows, the one placed above the other, in consequence of the contraction of the tube of the calyx, from which they arise. Now there are many instances of a similar anomaly among genera of the same order, and they exist even among species of the same genus. Examples of the latter are, *Nicotiana multivalvis* and *Nolana paradoxa*, and of the former, *Malope* among *Malvaceæ*; polycarpous *Ranunculaceæ* as compared with *Nigella*, and polycarpous *Rosaceæ* as compared with *Spiræa*. In *Prunus* I have seen a monstrous flower producing a number of carpella around the central one, and also, in consequence of the situation, upon the calyx above it; and finally, in the 'Revue Encyclopédique' (43. 762), a permanent variety of the apple is described, which is exactly to *Pomeæ* what *Punica* is to *Myrtaceæ*. This plant has regularly fourteen styles and fourteen cells, arranged in two horizontal parallel planes, namely, five in the middle and nine on the outside, smaller and nearer the top; a circumstance which is evidently to be explained by the presence of an outer series of carpella, and not upon the extravagant hypothesis of M. Tillette de Clermont, who fancies that it is due to the cohesion of three flowers." —*Lindley* (*l. c.*).

"To the *Myrteæ* we, with Mr. Lindley, unite the *Granateæ*, because *Punica* or the pomegranate only differs by having its two verticels of carpels developed instead of one, and perhaps in a truly wild state the upper or adventitious one may occasionally disappear. The inner series (or those at the bottom of the fruit) have their placentæ in the axis; but the outer series, forced to the top of the fruit by the contraction of the mouth of the tube of the calyx, having their placentæ in the ovary at the back of the inner carpels, exhibit them in the ripe fruit in a horizontal position on the upper surface of the lower cells."—*Arnott* (*l. c.*) *et Prod. Fl. Peninsulæ*, i. p. 327.

Premising that the whole controversy turns on these questions,—1st, what is the true structure of a pomegranate; and 2nd, whether the difference between it and *Myrtus* is sufficient to separate these genera as distinct orders;—I shall now proceed to examine these conflicting statements, and endeavour to ascertain on which side the balance preponderates, and whether, indeed, there is not room for an explanation different from any of those yet proposed.

Mr. Don's description of this fruit, on the strength of which he first proposed to remove this genus from *Myrtaceæ*, the order with which it was previously associated, as a distinct family, appears to me untenable. He, as I understand, considers the fruit a one-celled receptacle, the centre of which is filled with a spongy placenta, round the surface of which there are a number of irregular cells occupied by clusters of ovules; but he does not tell us how the central placenta got there, neither does he account for the ovules being attached to the parietes of the cell, and not to the central placenta.

DeCandolle gives a more correct description of it when he says, that it consists of two chambers, the under three-celled, the upper from five- to nine-celled, with the placentas of the upper cells reaching from the parietes to the centre, while those of the lower division proceed irregularly from the bottom of the fruit. He does not, however, assign this peculiar structure as his principal reason for viewing the order as distinct from *Myrtaceæ*, but has recourse to others, in my estimation, of minor importance.

Lindley conceives that there are two rows of carpels, three or four of which surround the axis at the bottom, while the remainder surround these, and, occupying the upper part of the fruit, adhere to that part of the tube of the calyx. The placentas of these upper carpels, he conceives, contract an irregular kind of adhesion with the back and front of their cells. The meaning of this is far from being clear to me; but if it means that he considers the placentas of the upper as well as the lower row to proceed from the axis towards the circumference, to which last they contract accidental adhe-

sions, then he takes an erroneous view; and if the examples quoted in illustration support this view, they are not in point as regards the structure of *Punica*.

Mr. Arnott, like Lindley, views the fruit as consisting of two rows of carpels, an outer and inner, the former of which he thinks may be adventitious. To understand his theory, we must first suppose the tube of the calyx spread out as a flat surface and covered with two circles of carpels, the inner next the axis, and the other occupying a larger circle beyond, and that the margin of the calyx then contracts so as to turn the outer series over the inner. According to this supposition, the attachment or base of the placentas of the outer series should be in the circumference and the apex in the centre, while that of the inner should be in the opposite direction, that is, have the base in the centre and the apex towards the circumference; an explanation which is in accordance with what we find, except in so far as it does not account for the horizontal partition between the two series: nor can I exactly understand on what ground we are warranted in assuming that the outer series is adventitious and the result of cultivation, as it has everywhere been found so constant in all circumstances. But be that as it may, this theory certainly accounts for the crossing of the placentas in the two rows which we so invariably find; whether correctly or not, cannot be determined until we get fruit with a single row of carpels, which has not yet been found.

These explanations, which I venture to propose, of rather obscure descriptions, did not occur to myself until after I had formed a new theory of my own, the result of a very careful examination of the ovary in all stages from the earliest up to the period of impregnation. At these early stages, when the whole flower had not yet attained half an inch in length, probably a fortnight or more before expansion, I invariably find two rows of carpels, one inferior of four or five, and one superior of five, six or more. In the lower series the placentas are ranged round the axis, with their base in the centre, and the apex, which is free, towards the circumference. In the upper, the attachment, or base of the placentas, is in the circumference, and the apex, also at first free, directed towards the centre. Between the two rows a diaphragm is always interposed. The apex of the upper placentas is, occasionally, afterwards prolonged and contracts adhesions to the axis.

In the accompanying figures I have attempted to represent these views. As the fruit advances in size considerable derangement of this structure progressively occurs, which is apt to mask and confuse the appearances now described.

Having previously ascertained the occasional existence of inversion in the position of carpels, my first idea was, that such an inversion took place in the upper row. This view, which, equally with the preceding, accounts for the crossing of the placentas, I feel inclined to adhere to, though I confess not without some hesitation, because it implies a complexity of arrangement rarely met with in the inimitably simple and beautiful operations of nature; but I think it as difficult to imagine the nearly equally complex and inconceivable operation of the folding-in of one set of carpels over the other, which Drs. Lindley and Arnott's explanation demands: while my explanation has the advantage of at the same time accounting for the double chamber which the ovary presents from its earliest stages, and renders unnecessary the doctrine of an adventitious verticel of carpels, which for the present is mere assumption.

With these explanations, I leave the question of structure to consider the one pending on its determination, viz. whether or not *Granateæ* ought to be preserved as a distinct order, or be re-united to *Myrtaceæ*.

On this point, so far as the unvarying evidence derived from cultivated plants is entitled to carry weight on a disputed point —and which I presume it must do until we find that evidence invalidated by the examination of others growing in a truly wild state—we must unquestionably, I conceive, adopt the views of those who urge the separation, because the complex structure above described, being constant here and unknown among the true *Myrtaceæ*, we have no right, in the total absence of direct confirmatory evidence, to assume that a part is adventitious merely because it is at variance with our ideas of what should be, especially while we have, in addition, difference of habit in the formation of the seed and their pulpy envelope, in further confirmation of the correctness of these views.

To the views of DeCandolle more importance must necessarily be attached, as the reasons he assigns are more satisfactory, though I do not think he has attached sufficient value to the very peculiar "œconomy of the fruit," while he has given too much to others of much less note, such as the want of pellucid dots, the absence of the marginal nerve of the leaves, and the pulpy covering of the seed; thereby throwing into the shade the true essential character of the order, which unquestionably lies in the double row of carpels, with the upper placentas parietal and crossing the lower axillary ones, which, if I have rightly accounted for, constitute this a truly curious and unique fruit; and which, whether or not my

theory of its construction be correct, is yet so very different from that of every true *Myrtacea*, as to leave no doubt of its forming the type of a distinct order.

Fig. 1.

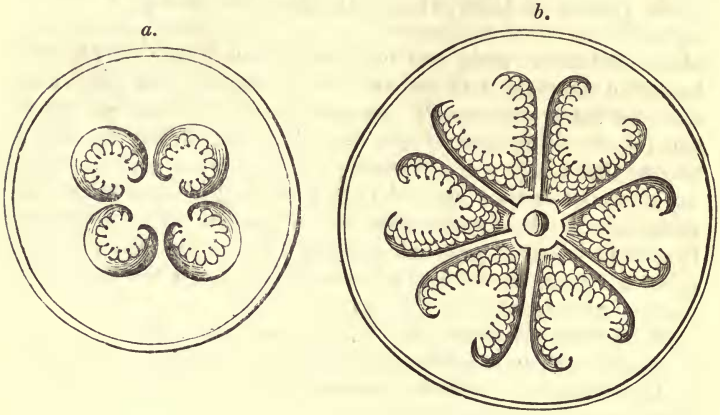
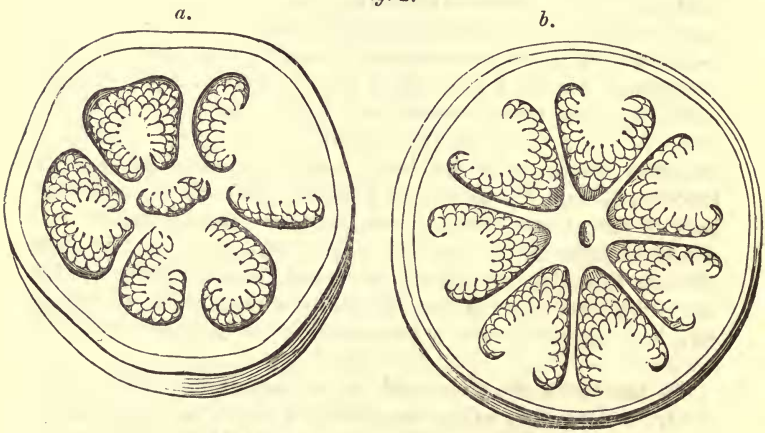


Fig. 2.



EXPLANATION OF THE FIGURES.

Fig. 1.—*a.* Section showing the lower series of carpels in the ovary of the Pomegranate many days before the expansion of the flower.

b. Section showing the upper series of carpels. These two figures are taken from opposite sides of the same slice.

Fig. 2.—*a.* Section showing the lower series of carpels in an ovary some days after the expansion of the flower. At this time considerable derangement has taken place, apparently caused by the rapid expansion, in a confined space, of the ovules after impregnation.

b. Upper series in the same ovary, and, as in the former instance, taken from the opposite sides of the same slice. Here the derangement so obvious in the lower section has not taken place.